Babcock & Wilcox

Power Generation Group

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August 9, 1978

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RANCHO SECO
MAR 20, 1978

Mr. T. D. Murray, Station Superintendent
Davis-Besse Nuclear Power Station
5501 North State Route #2
Oak Harbor, Ohio 43449

Subject: SMUD Rapid Cooldown Transient

Dear Terry:

On March 20, 1978, Rancho Seco experienced a severe thermal transient initiated by the loss of electrical power to a substantial portion of the Non-Nuclear Instrumentation (NNI). The loss of power directly caused the loss of Control Room indication of many plant parameters, the loss of input of these parameters to the plant computer, and erroneous input signals (midrange, zero, or otherwise incorrect) to the Integrated Control System (ICS).

The plant response was not the usual transient in that the ICS responded to the erroneous input signals rather than actual plant conditions, and resulted in a Reactor Protection System (RPS) trip on high pressure. Subsequent to the Reactor Trip, the erroneous signals to the ICS contributed to the rapid cooldown of the RCS. Plant operators had extreme difficulty in determining the true status of some of the plant parameters and in controlling the plant because of the erroneous indications in the Control Room.

An investigation of the events following this loss of power points out a need for a close look at operator training and emergency operating procedures for any loss of NNI power (or portion thereof). The following recommendations are made to assist your staff in a review of training and procedures to assure proper operator action for events of this nature.

1. Operators should be trained to recognize a loss of power to all or a majority of their NNI (e.g. indicators fail to mid-range, automatic or manual transfer to alternate instrument strings brings no response). The loss of power is emphasized here rather than the failure of any one instrument or control signal which are adequately covered in current simulator training courses.

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2. Given that the operator can determine that electrical power has been lost to all or part of the NNI, he should know the location of the power supply breakers, and have a procedure available to quickly regain power.

3. If the fault cannot be cleared (i.e. the breakers to the power supplies reopen), the operator should have a list of alternate instrumentation available to him, and he should be thoroughly trained in its use. Examples are:

   a. ESFAS panels
   b. RPS panels
   c. ECI (Essential Controls and Instrumentation)
   d. SRCI (Safety Related Controls and Instrumentation)
   e. Remote shutdown panels
   f. Local gages
   g. Plant computer

4. Recognizing that no procedure can cover all possible combinations of NNI failures, the operator's response should be keyed to certain variables. If the operator realizes that he has an instrumentation problem (as opposed to a LOCA or steam line break, for example), he can limit the transient by controlling a few critical variables:

   a. Pressurizer level (via HPI or normal Makeup Pumps)
   b. RCS pressure (via Pressurizer heaters, spray, E/M relief valves, etc.)
   c. Steam Generator level (via feed flow, feedwater valves, etc.)
   d. Steam Generator pressure (via turbine bypass system)

   The pressurizer level and RCS pressure assure that the Reactor Coolant System is filled; the Steam Generator level and pressure assure adequate decay heat removal.

Attachments 1 and 2 are provided to give a brief description of the events following this loss of NNI power at Rancho Seco. As can be seen by this transient, prompt precise operator action and the ability to recognize a loss of NNI power are critical factors in limiting the severity of a transient such as this.

If you have any questions or comments, please advise.

Yours truly,

Ivan D. Green
Site Operations Manager

IDG:TFS:mlf
encl.
cc: See attached sheet.

ATTACHMENT 1

SEQUENCE OF EVENTS - SMUD 04:25 to 05:34 - MARCH 20, 1978

(Revision 1, 5/25/78)

	EVENT
:35	- Lost NNI power supply cabinets 5, 6, & 7
	- This caused a loss of valid signals to the ICS. BTU limits ran back feedwater, resulting in a partial loss of feedwater (actual Rx power was 72%).
	- Probable opening of "B" turbine bypass valves to the condenser (timing uncertain).
25:44	- Reactor trip on high pressure, turbine trip on interlock.
	- Pressurizer code relief setting was known to be low (approximately 2225 psig). The electromatic relief was isolated due to previous leakage problems. The data indicates primary pressure went ≈2400 psig => code relief valve lifted.
	- ICS closes main control and start-up feed valves and drive main feed pumps to minimum speed following trip.
	- Decay heat and RC pumps energy removal accomplished through generators by inventory boil off and the addition of main feedwater.
:26:15	- Pressurizer code relief valve reseats at approximately 2100 psig.
	- Operator starts HPI pump "B".
:28:23	- Operator stops HPI pump "B".
:30	- OTSG "B" pressure reaches 435 psig set-point of Steam Line Failure Logic.
	- OTSG "B" goes dry.

- Operator increases speed of a MFP and feeds "A" OTSG. This starts RCS on pressure and temperature decrease.

:4:25 - RC pressure ≈1900 psi

:7:16 - SFAS actuation at 1600 psig

This starts HPI, LPI and initiates emergency feed. The emergency FW pump is started and the bypass emergency FW valves are opened to full open position. The system makes no automatic attempt to control steam generator water level.

40 - RC pressure at 1475 psig. It starts to recover from this point due to HPI. T_{ave} = 523°F.

:43:56 - "A" HPI pump secured.

:46:09 - LPI secured.

:49:54 - "A" HPI initiated. From this point on, the operator started and stopped HPI pumps as necessary to maintain pressurizer level.

:50 - Steam Line Failure Logic closes ICS-controlled start-up feed valves to each OTSG when the corresponding OTSG pressure falls below 435 psig.

:51:25 - Secured RCP-D (T_{ave} ≈435°F) This reduced #RCP's to three

:57:27 - OTSG "A" water level - 599.""

Speculate that ≈2 ft. of tubes are not flooded (at top) due to steam line arrangement.

:00:00 - Hourly computer log print-out
Steam temp. 380°F (OTSG "B")
Steam pressure 171 psig (OTSG "B")

Assuming $T_{ave} = T_{sat} \Rightarrow T_{ave}$ = 380°F

13:47 - OTSG "B" level - 599.1"

:34 - Power restored to NNI cabinets 5,6,&7

$T_{ave} = 235^{\circ}F$

RCS Pressure ≈2000 psig

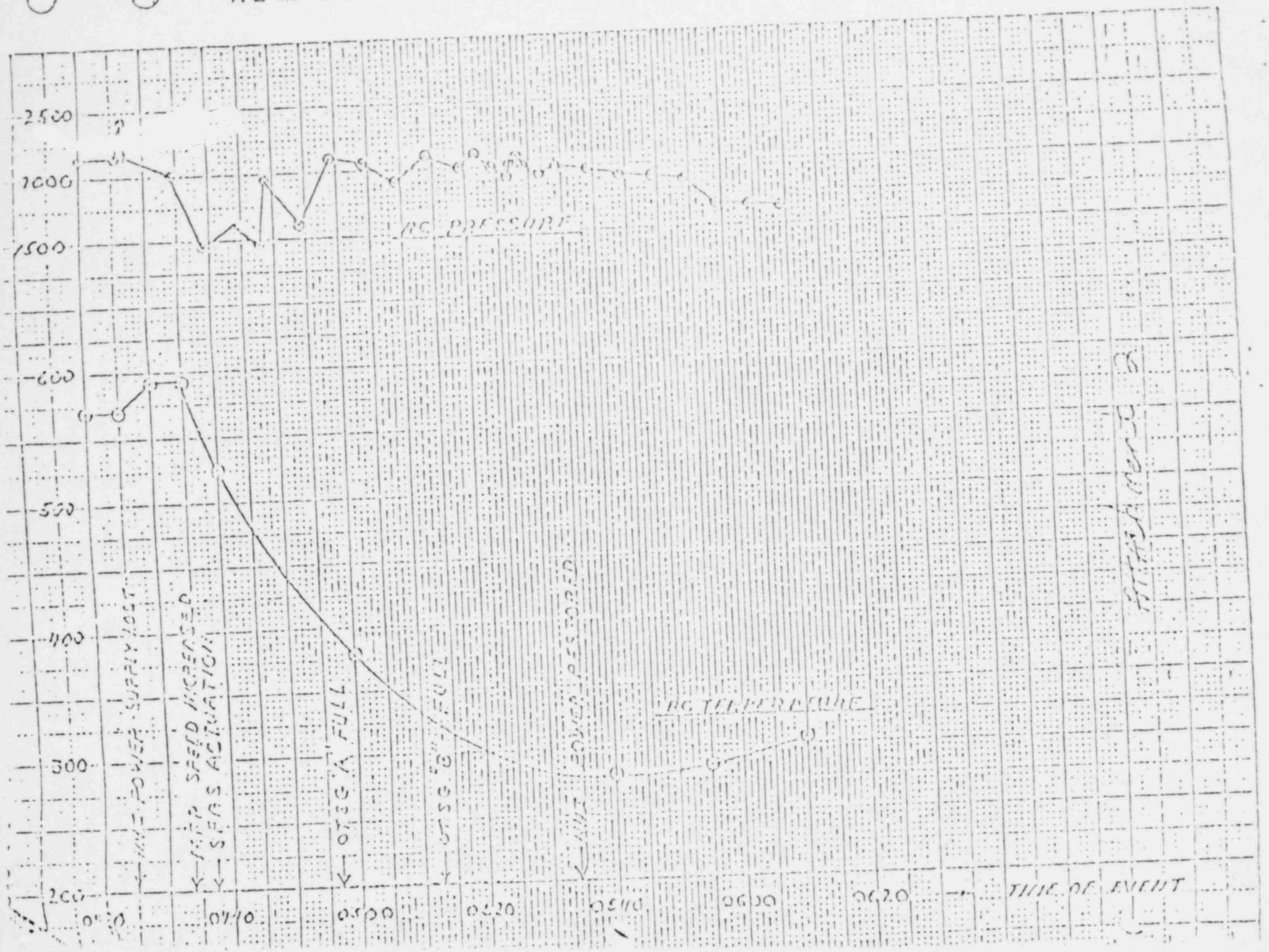
Both OTSG full level ranges pegged high

Operator begins to reduce RC pressure using pressurizer spray.

ICS closes turbine bypass valves to condenser.

Operator stops emergency FW flow.

Operator stops main FW pumps.



2500
2000
1500
600
500
400
300
200
RC PRESSURE
RC TEMPERATURE
MAIN POWER SUPPLY LOST
MFP SPEED INCREASED
SFAS ACTUATION
OTSG 'A' FULL
OTSG 'B' FULL
MAIN POWER RESTORED
0430
0440
0450
0520
0540
0600
0620
TIME OF EVENT

K+E 10 X 10 TO ½ INCH • 7 X 10 INCHES KEUFFEL & ESSER CO.

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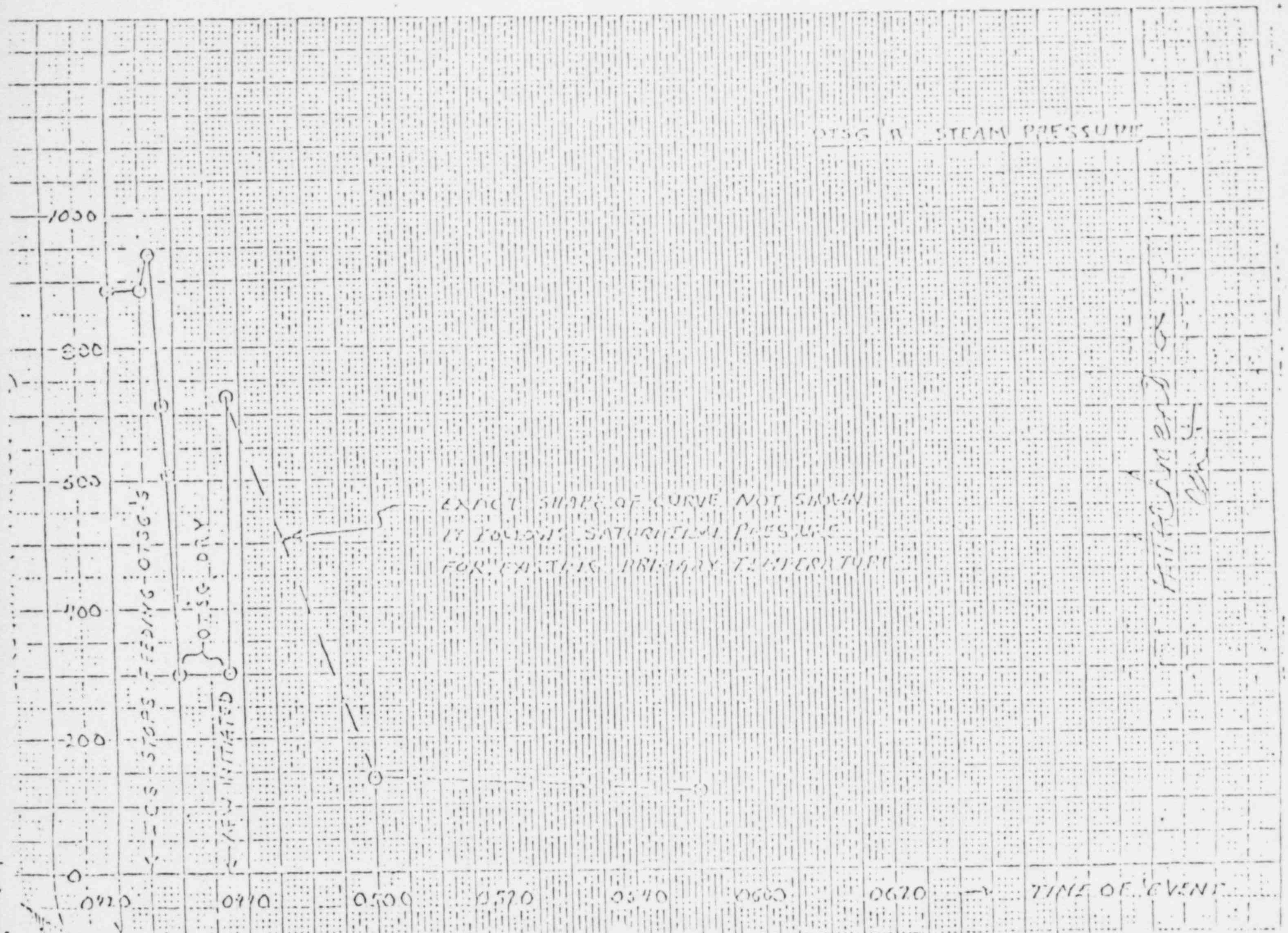

K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO.

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